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U. S. DEPARTMENT OF COMMERCE

Technical News Bulletin

of the

National Bureau of Standards

★   *Issued Monthly*   ★

CONTENTS

DESIGN AND CONSTRUCTION OF ECLIPSE APPARATUS

"The Design and Construction of Eclipse Apparatus" by Irvine C. Gardner is one of several papers included in a monograph to be published by the National Geographic Society which gives the scientific results of the 1940 eclipse expedition sponsored by the National Geographic Society and the Bureau. Four major instruments—two spectrographs and two corona cameras—were specially designed and constructed for this expedition.

The spectrographs are of the slitless type equipped with concave gratings of approximately 21-foot radius of curvature. The spectrum photographed by each instrument is 40 inches long, one spectrograph photographing the range of wavelengths from 3,000 to 5,500 A; the other from 5,000 to 10,000 A. These instruments were operated by C. C. Kiess, who, in a separate paper, discusses the spectrogram which was obtained. The corona cameras are equipped with $f/15$ anastigmatic lenses of $47\frac{1}{2}$-inch focal length. The negative size is 9 by 9 inches, and the photographs are made on roll film carried in a film magazine that is entirely automatic in operation. One of the corona cameras is provided with a Polaroid disk in front of the lens and an automatic motor drive by which the disk is rotated 45 degrees between successive exposures. The four instruments were taken to Brazil and erected at Patos in Parahyba do Norte, a town approximately 200 miles inland from Recife. Unfortunately, although the morning of October 1, 1940, was clear, clouds obscured the sun throughout the period of totality. One successful spectrogram was obtained, but the corona pictures, taken through the thinner portions of the cloud layer, were lacking in structural detail, and an extended series of photographs such as is required for a study of the polarization could not be made. (See Technical News Bulletins 282 and 283; October and November 1940.)

RADIO OBSERVATIONS OF THE IONOSPHERE DURING AN ECLIPSE

With the beginning in about 1925 of long-distance radio communication at high frequencies, interest in the iono-

sphere also commenced. Since that time a great deal of work, both experimental and theoretical, has been carried on at a number of places in this and other countries in the study of the properties of the ionosphere. The ionosphere is made up of two and sometimes three more or less well-defined ionized layers which are capable of returning radio waves to the earth. The lowest of these, the E layer, is found at about 68 miles above the surface of the earth, the F_1 between 87 and 155 miles, and the F_2 between 90 and 250 miles. All radio transmission over long distances takes place by virtue of refraction of the waves back to earth from one or another of these ionized layers. For example, transmission over a distance of 4,000 miles may require two hops with the wave striking the ionosphere at two places. The need for more than one jump for long distances is caused by the earth's curvature.

Since the sun is the main, if not the sole source of the ionizing force responsible for the formation of the ionized regions, it is of interest to study the ionosphere in terms of time of day, season, sunspot cycle, and any other occurrence which affects the amount of energy reaching the ionosphere. As an example of the amplitude of the changes, the ion density of the F_2 region may vary over a range of 10 to 1 between day and night and over a range of 4 to 1 from sunspot maximum to sunspot minimum.

The regular experiments which are being carried on continuously give a measure of the heights and densities of ionization of the layers, so that it is possible to interpret and predict the characteristics of long-distance radio transmission.

One of the important factors in the study of the ionosphere is the rate of recombination of the ions. Although an estimate may be made of the recombination coefficient from diurnal curves, a solar eclipse gives a unique opportunity for its determination, since the ionizing force is cut off rapidly. Besides being important in the study of the ionosphere, a knowledge of the recombination coefficients of the various layers gives a check on the estimates of temperatures and pressure in the high atmosphere.

Measurements of heights and ion densities were made during the eclipse described in the preceding item, and from the values measured, recombination coefficients have been estimated for the various layers. The results of these measurements will be published as one

of the papers in the eclipse monograph of the National Geographic Society.

During the eclipse, which had a period of totality of 282 seconds at the ground, the ion density of the E and F_1 layers decreased to about 22 percent of normal. The minimum density corresponds to a recombination coefficient of about 2×10^{-8} for the E layer and about 10^{-8} for the F_1 layer. The rate of decrease, however, and the fact that the time of minimum density occurred at the middle of totality, indicate much g r e a t e r coefficients. An apparent anomalous effect was observed in that the ion density began to increase before the third contact.

In the case of the F_2 layer, information was not complete, but the minimum of ion density approached approximately half of normal, and apparently reached a minimum about an hour after totality. Up to the end of totality the decrease in ion density corresponded to a recombination coefficient of about 10^{-10}, but the density observed some time after totality was much less than would have been expected for this coefficient.

A definite decrease in ion density was observed at the same time that the moon obscured a large sunspot. This may be significant in identifying the source of certain ionizing radiation with given areas of the sun.

A PHYSICAL PHOTOMETER

Photometry has been carried on for many years by means of visual observations, not because the eye is an accurate measuring instrument but because there has been no physical apparatus which would respond with sufficient accuracy to light in the same manner as the human eye. Even experienced observers may obtain markedly different results because they will not agree as to when two illuminated surfaces are equally bright.

The luminosity factors of the International Commission on Illumination have been accepted internationally to represent the characteristics of the eye of a "standard observer." A physical photometer which "sees" light in accordance with these factors has been constructed. The results which it gives are consistent with the ICI values and they are more accurate than those of visual observers when the light transmissions of colored filters are measured by heterochromatic photometry. The construction and operation of this physical photometer are described in a paper by Ray P. Teele in the September number of the Journal of Research (RP1415).

TESTING AND PERFORMANCE OF VOLT BOXES

The American public pays bills for electric energy which aggregate over two billion dollars annually. RP1419 by Francis B. Silsbee and Francis J. Gross, which will be published in the Journal of Research for September, and which deals with the testing and performance of volt boxes, has a direct bearing on these bills, because they are based on the readings of electric meters, the accuracy of which in turn is checked from time to time by comparison with standards carefully maintained in the laboratories of the public-utility companies.

A volt box, which serves in the accurate comparison of the line voltage with that of the standard cell, is a necessary link in the chain of measurements by which the values of the companies' standards are fixed.

This paper describes the methods used at the Bureau in testing the accuracy of the volt boxes submitted by the utility companies, manufacturers, scientific laboratories, and others, and indicates the extent to which such apparatus maintains its accuracy in spite of variations in atmospheric and other conditions.

INSTALLATION REQUIREMENTS FOR HEAD METERS

During the past 15 years the effects that installation conditions may have upon the indications of head meters (meters in which the indication is obtained from the difference in head at two points, as in the Venturi meter) have been studied by several different groups. The first of these was a committee of the American Gas Association, which conducted a series of tests near Buffalo, N. Y., during the summers of 1926 and 1927. Within the past 2 years the Fluid Meters Committee of the American Society of Mechanical Engineers has made tests on the subject as a supplement to its research program on flow nozzles. Others who have studied the problem and published their results are R. Witte in Germany and W. S. Pardoe at the University of Pennsylvania.

The results of the tests made by these several groups were reviewed by Howard S. Bean of the Bureau, who expressed them in uniform manner and arranged them in tabular form. It was then possible to combine the values in these tables, which applied to similar arrangements of piping, in such a manner as to show the lengths of straight pipe that should precede the differential producer of a head meter. This has been done for three general arrangements of the inlet piping, and the straight-pipe requirements thus determined are presented in the form of curves.

The straight-pipe requirements shown by these curves are those which should be sufficient to keep the effect of the installation conditions from exceeding 0.5 percent. No attempt was made to determine the lengths of pipe that might be required to reduce the effects to a possible zero. To have done so would have required more or less extrapolation from the test results. Furthermore, the direction of the effect is not always the same; indeed, in a few cases it appeared to change from plus to minus as the length of straight pipe was changed.

In preparing the curves to show the straight-pipe requirements, no distinction was made between the three principal types of differential producers, namely, square-edged orifice, flow nozzle, and Venturi tube, and the curves are intended to be equally applicable to each of these.

HEATS OF ISOMERIZATION OF HEXANES

In RP1420, which appears in the September number of the Journal of Research, Edward J. R. Prosen and Frederick D. Rossini report the results of the calorimetric determination of the ratios of the heats of combustion of the five hexanes in the liquid state. From these and auxiliary data, the authors have calculated the heats of isomerization for the liquid state at 25° C, and for the gaseous state at 0°, 298°, 600°, and 1,000° K. At 25° C, the heat evolved in the isomerization of the normal isomer into each of the others for the gaseous state, is as follows, in kilocalories per mole: n-hexane, 0.0; 2-methylpentane, 1.68 ±0.23; 3-methylpentane, 1.09 ±0.21; 2,3-dimethylbutane, 2.58 ±0.22; and 2,2-dimethylbutane, 4.44 ±0.21.

MUNSON AND WALKER REDUCING-SUGAR TABLES

The Munson and Walker method of reducing-sugar analysis is the only one of the older gravimetric processes which in this country has survived to the present day. Recently, Hammond (J. Research NBS 24, 579 (May 1940) RP 1301) has undertaken a comprehensive revision of the empirical copper equivalents and has disclosed discrepancies much greater than the errors of analysis. In RP 1417 by Richard F. Jackson

and Emma J. McDonald in the September Journal of Research it is now shown that the cause of these discrepancies was the contamination of the cuprous oxide, which Munson and Walker weighed directly for the estimation of copper. An independent series of analyses made by the authors, who determined the copper iodometrically, was found to be in good agreement with the analyses of Hammond, who determined the copper electrolytically. The recommendation is made that the Hammond copper equivalents be adopted in substitution for those of Munson and Walker. It is also recommended that the copper be determined analytically, since the cuprous oxide is inevitably contaminated, even when pure substances are analyzed.

Methods are given for the preparation of standard invert sugar. It is shown that invert sugar equal in reducing power to synthetic invert sugar can be prepared by inversion of sucrose if the inversion is carried out at room temperature.

Detailed methods for the determination of reduced copper are described.

DENSITY OF CRYSTALLINE RUBBER

The density of crystallized rubber may be computed from the results of X-ray investigations or it may be determined directly by well-known methods. If the computed density agrees with that found by direct measurement, it serves to confirm the structure on which the calculated value was based, and direct observations of the density could be used to determine the degree of crystallization. Unvulcanized rubber may be crystallized by stretching it at room temperatures or by subjecting it to appropriate low temperatures. When it is stretched quickly, an orientation of structure occurs parallel to the direction of elongation, the rubber crystallizes, and a change of volume takes place. Rubber crystallized by stretching appears as spots in the X-ray pattern, that crystallized by chilling appears as rings, but their measurements agree closely. In the past, the calculated densities have been greater than unity. More recent calculations have given lower values, the lowest being 0.965.

In recent work at the Bureau, W. Harold Smith and Nancy P. Hanna have determined by direct experiment the densities of amorphous rubber, of unstretched crystallized rubber, and of rubber crystallized as completely as possible by stretching it. The report

of the work will be published in the September Journal of Research as RP1416. With the amorphous material, the determinations were made in distilled water at 25° C. With the crystallized material, they were made by weighing the rubber immersed in a mixture containing equal parts by weight of acetone and water, or in amounts adjusted to make the mixture of the same density as the specimen, and then the density of the liquid was determined. The measurement was made at −10° C, which is below the lowest observed melting point of crystalline rubber produced from ethereal solution. At 25° C, the density of amorphous smoked sheet was found to be 0.906. With purified, amorphous petroleum ether-sol rubber, the values ranged from 0.899 to 0.902 with different preparations of material. These densities are lower than any reported in the literature. The range is much less than the differences reported for the densities obtained with impure, and for others obtained with pure, total rubber.

At −10° C, the density of crystalline, unstretched smoked sheet varied from 0.950 to 0.952; that of crystalline petroleum ether-sol rubber ranged from 0.948 to 0.951. The density of amorphous smoked sheet at −10° C was 0.932, which was calculated from the value of 0.906 observed at 25° C. That of amorphous petroleum ether-sol at −10° C was 0.928, based on 0.902 observed at 25° C. Smoked sheet stretched almost to the breaking point, and crystallized further at −15° C, had a density of 0.960 at −10° C. Stretching caused an increase not more than 0.01 greater than that of unstretched crystallized rubber. The increase in stretched rubber is generally believed to be caused by a form of packing in crystallization of a fibrous type. Higher densities were found only by racking the rubber, that is by warming and stretching rubber repeatedly; by this technique very high elongations are possible. It is reported in the literature that the density becomes constant at 2,000-percent elongation. Its value observed at some room temperature was 0.953. The density at 2,000-percent elongation appears to be that of completely crystallized rubber and, when corrected for the temperature used in any X-ray investigation, is a reasonable guide for deductions about structure.

CARBON DIOXIDE AND WATER EVOLVED FROM LEATHER

The oxidation of vegetable-tanned leathers has been associated with the darkening of the colors of solutions and

of materials containing tannin, with the difficulty in determining the moisture content of leathers, and with the deterioration of vegetable-tanned leathers in storage. In previous studies, it was shown that when vegetable-tanned leathers were heated in the presence of air or oxygen at 100° C, carbon dioxide was evolved. The amounts of carbon dioxide evolved at a constant temperature varied linearly with the percentages of the total nitrogenous materials extractable by a 0.1 N solution of sodium carbonate after these leathers had been subjected to oxygen under pressure.

RP1418 in the September Journal of Research describes a more nearly complete study by Joseph R. Kanagy of the oxidation of vegetable-tanned leathers. The rates of evolution of carbon dioxide and water from untanned hide powder and from chestnut-, quebracho-, cutch-, and sumac-tanned leathers in the presence of oxygen or air, or of an inert gas, nitrogen or helium, in the range of temperature from 60° to 140° C, were determined. Hide powder evolves much less carbon dioxide and water than the leathers. The rates of evolution of carbon dioxide from the leathers in air and in oxygen in the majority of cases increases by a factor of approximately 3 for every 20° C rise in temperature. Since considerable amounts of carbon dioxide and water are produced in the presence of oxygen or air, but very little in the presence of an inert gas, the reaction appears to be an oxidation. The amounts of carbon dioxide emitted give a straight-line correlation with the percentages of the total nitrogenous materials extractable by a 0.1 N solution of sodium carbonate from leathers treated under the same conditions.

BREAKING STRENGTH AND ELONGATION OF COTTON YARNS

The breaking strength and the elongation of cotton yarns were found to vary significantly not only with the rate of loading in a test but also with the type of testing machine used. These results, which therefore have an important bearing in the preparation of specifications and the testing of textiles, are reported and discussed in a paper (RP1422) by Herbert F. Schiefer and Richard S. Cleveland which will be published in the September Journal of Research.

Single-strand tests for breaking strength and elongation of cotton yarns, varying in size and amount of twist, were made, using the pendulum and the inclined-plane types of testing machine.

Two rates of loading were used with each machine. The results also give information regarding the corrections of these machines, variability of the yarns, and the number of tests required for a given precision and probability. The effect of rate of loading on the breaking strength and elongation is discussed. The tests on the inclined-plane machine yield a significantly higher breaking strength and a lower elongation than the tests on the pendulum machine. These unexpected differences are not attributable to a difference in the rate of loading between the two machines but are explainable on the basis of the mechanics of the two types of machine.

SIMPLIFIED PRACTICE RECOMMENDATION FOR SURGICAL GAUZE

Simplified Practice Recommendation R86–41, Surgical Gauze, now available in printed form, covers a simplified schedule of yarns per inch, widths, and lengths for surgical gauze, crinoline, bandage rolls, sterile gauze bandages, and sterile gauze in sealed cartons.

As originally drafted by a general conference of the industry and promulgated in 1928, the recommendation listed 38 stock varieties, and eliminated about 32 items for which there existed very little demand. The standing committee reaffirmed the recommendation without change in 1930 and 1933, and in 1937 revised it by eliminating nine additional items no longer in active demand.

The current revision accomplishes a further reduction of three items—the 36-inch surgical gauze, 22 warp and 18 filling yarns per inch; the 38½-inch crinoline, 44 warp and 40 filling yarns per inch; and the 6-yard, 1½-inch bandage. Minor changes have been made to clarify the recommendation and to provide packaging methods for sterile gauze bandages.

Copies of R86–41 can be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., for 5 cents each.

PACKAGING OF FIRST-AID UNIT DRESSINGS AND TREATMENTS

Simplified Practice Recommendation R178–41, which bears the above title and which is now available in printed form, was sponsored by the First-Aid Section of the Industrial Safety Engineering Association, and its purpose is to simplify the packaging of first-aid unit dressings and treatments and the maintenance of industrial first-aid kits, by establishing three standard carton

sizes, four standard kit sizes, and a simplified schedule of dressings and treatments to be packed in the respective cartons. Elimination of odd sizes of packages will facilitate purchasing and handling of dressings and treatments and the replenishing of kits. The use of standard cartons will obviate the necessity of repackaging and rewrapping, and insure that the contents will remain clean and sanitary.

Copies of R178–41 may be purchased from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents each.

TYPEWRITER RIBBONS AND CARBON PAPER

Because of the widespread use of typewriter ribbons and carbon paper it is natural that a great many persons should be interested in them, especially in how they are manufactured and tested. Circular C431, Typewriter Ribbons and Carbon Paper, recently issued by the Bureau, discusses the materials used and the principles involved in the manufacture of the ink for ribbons and the coating for carbon paper. No formulas are given in the Circular because of the impossibility of obtaining any that are representative of those now being used by the more progressive manufacturers. New natural waxes come on the market from time to time, and synthetic waxes and other materials are becoming available in increasing numbers. Experiments are being made with these to find to what extent, if at all, they can take the place of the older raw materials for the ink and carbon coating. The manufacturers cannot be expected to tell what they find out about them.

The methods for testing ribbons and carbon paper are described in enough detail to make it possible for the reader to test his own purchases of these supplies. There is a section on the typewriter to give the reader a better understanding of the general discussion of ribbons and carbon paper, and of the methods for testing them. There is also a section on the hectograph, because special ribbons and carbon paper are made to use with it.

Copies of C431 are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is 10 cents.

PHASE-EQUILIBRIUM STUDIES INVOLVING POTASH

An investigation by William C. Taylor, reported in the Journal of Research for September (RP1421), is one of a series of studies undertaken to determine the manner in which K_2O is combined in portland cement clinker.

The results of previous investigations showed the stability of the compound $K_2O.Al_2O_3$ in that portion of the K_2O-$CaO.Al_2O_3$ system studied, and also its stability in the presence of $4CaO.Al_2O_3.Fe_2O_3$ and $2CaO.Fe_2O_3$.

Preliminary work showed that $K_2O.Al_2O_3$ is unstable in the presence of $2CaO.SiO_2$ and $3CaO.SiO_2$, and these results led to the study of the relations of $2CaO.SiO_2$ and $K_2O.CaO.SiO_2$. The compounds $2CaO.SiO_2$ and $K_2O.CaO.SiO_2$ form a binary system containing one additional compound having the formula approximating $K_2O.23CaO.12SiO_2$. The stability of this compound of potash in portland cement clinkers composed of K_2O, CaO, Al_2O_3, SiO_2, and Fe_2O_3 was indicated. No other compound containing K_2O was observed.

SIMPLIFIED PRACTICE RECOMMENDATION FOR STRUCTURAL INSULATING BOARD

Simplified Practice Recommendation R179–41, Structural Insulating Board (Vegetable Fiber), which has recently been released, concerns not only sizes and thicknesses, but also colors, finishes, and the treatment of edges for the various structural insulating board products. Copies are obtainable at 5 cents each from the Superintendent of Documents.

STRUCTURAL AND HEAT-TRANSFER PROPERTIES OF "U. S. S. PANELBILT" HOUSE

Recently the Tennessee Coal, Iron & Railroad Co. submitted 42 specimens representing its "U. S. S. Panelbilt" prefabricated sheet-steel house constructions for test at the Bureau. There were two wall constructions, a partition construction, and a roof construction. The results are now available as Building Materials and Structures Report BMS74, copies of which are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 15 cents each.

The wall specimens were subjected to compressive, transverse, concentrated, impact, and racking loads; the partitions to concentrated and impact loads; and the roofs to transverse and concentrated loads. The transverse, concentrated, and impact loads were applied to both faces of the wall specimens. For each of the loads three like specimens were tested. The loads simulated those

to which the elements of a house are subjected in actual service.

The deformations under load and the sets after its removal were measured for each increment of load. The results are presented in graphs and tables.

The heat-transfer properties were determined for one wall specimen by means of tests in a shielded hot-box heat-transfer apparatus. The results are given in a table.

ROOFING MATERIALS ON DWELLINGS IN NORTH CENTRAL STATES

The results of a survey of the weathering qualities and the extent of use of the various roofing materials on dwellings in the North Central States, with numerous references to similar surveys made previously in the Southeastern and Northeastern States, are given in Building Materials and Structures Report BMS75, which has just been released.

Detailed studies are reported of roofing materials in Pittsburgh, Pa.; Cincinnati and Toledo, Ohio; Grand Rapids and Lansing, Mich.; Chicago, Ill.; Milwaukee, Wis.; St. Paul, Minn.; Bismarck, N. Dak.; Sioux Falls, S. Dak.; Omaha, Nebr.; Kansas City, Moberly, and St. Louis, Mo.; and Indianapolis, Ind.

Forty-eight photographs, illustrating types of weathering of roofing materials, and features of design and construction of roofs, are shown.

A tabulation, by States, of the kinds of roofing materials used on more than 8,000 rural and small-town dwellings, along approximately 3,000 miles of highway between the cities listed above, is included; also a summary of the kinds of roofing materials used on almost 29,000 rural and small-town dwellings along 7,000 miles of highway in the 32 States covered by the three surveys.

Copies of this publication, BMS75, are obtainable at 15 cents each from the Superintendent of Documents, Government Printing Office, Washington, D. C.

REVISED COMMERCIAL STANDARD FOR DIAMOND CORE DRILL FITTINGS

A revision of the Commercial Standard for diamond core drill fittings, designated CS17–42, is now available in printed form. This records standard dimensions, tolerances, and terminology of fittings, and extends the interchangeability of parts to new, thin-wall core barrels, core-barrel bits, and reaming shells which are designated EXT and AXT. It also covers new standard dimensions and tolerances to provide interchangeability of flush-joint casings.

The seal used by the Diamond Core Drill Manufacturers Association to indicate equipment manufactured according to the standard is illustrated. The identification of items conforming thereto will not only provide the essential interchangeability and minimize the difficulty of replacing parts in the field but will bring about a better understanding between buyers and sellers and serve as a yardstick of acceptability of these fittings.

Copies of CS17–42 are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each.

NEW AND REVISED PUBLICATIONS ISSUED DURING AUGUST 1941

Journal of Research [2]

Journal of Research of the National Bureau of Standards, volume 27, number 1, July 1941 (RP1398 to RP1405, inclusive). Price 30 cents. Annual subscription, 12 issues, $3.50.

Research Papers [2]

[Reprints from May and June 1941 Journal of Research]

RP1383. Hazard of mercury vapor in scientific laboratories. Martin Shepherd and Shuford Schuhmann, and Robert H. Flinn, J. Walter Hough, and Paul A. Neal. Price 10 cents.

RP1384. Field equipment for ionosphere measurements. Theodore R. Gilliland and Archer S. Taylor. Price 15 cents.

RP1385. Development of texture in copper by cold-rolling. Herbert C. Vacher. Price 10 cents.

RP1386. Colorimetric determination of phosphorus in steel and cast iron. John L. Hague and Harry A. Bright. Price 5 cents.

RP1387. Method for determining the components of asphalts and crude oils. O. G. Strieter. Price 5 cents.

RP1388. Methods for determining sound transmission loss in the field. Albert London. Price 10 cents.

RP1389. Metastability of cadmium sulfate and its effect on electromotive